PATENT ABSTRACTS OF JAPAN

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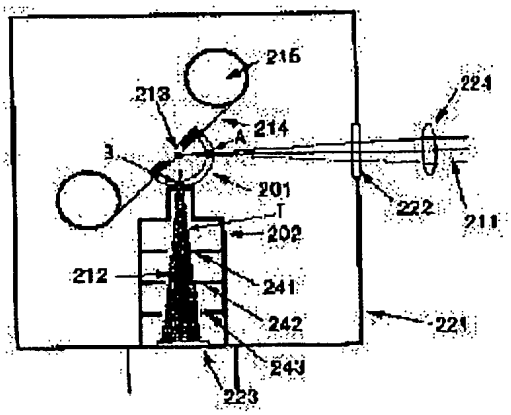
(54) X-RAY GENERATING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To reduce attachment or deposition of an inconvenient scatter grain in an X-ray discharge direction for stably using a device for a long time in the case of using buffer gas for prohibiting the scatter grain.
SOLUTION: An excitation energy beam is applied to a target member 214 in a pressure-reduced vacuum container 221 to form plasma 213, where buffer gas is used for prohibiting a scatter grain discharged from the target member 214 and/or the plasma 213. In this case, a member having an aperture part A for an excitation energy beam 211 to pass and a separate aperture part B for an X-ray 212 to pass is provided close to the target member 214 and the plasma 213 as a scatter grain shielding member 201 to shield the scatter grain discharged from the target member 214 and/or the plasma 213. In addition, a scatter grain prohibiting member 202 is provided adjacent to or close to a three-dimensional angular range equivalent to a range where the X-ray 212 is taken out.



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CLAIMS

[Claim(s)]
[Claim 1] Irradiate an excitation energy beam and the plasma is made to form in the target member in the decompressed vacuum housing. In the X-ray generator which uses a buffer gas in order to prevent the scattering particle which is the X-ray generator which takes out an X-ray from this plasma, and is emitted from said target member and/or said plasma It is the member which has opening which said excitation energy beam passes, and another opening which said X-ray passes. The scattering particle electric shielding member which covers the scattering particle emitted from said target member and/or said plasma is prepared near said target member and the plasma. And the X-ray generator characterized by preparing the scattering particle inhibition member which adjoins or approaches in the solid angle field equivalent to the range which takes out said X-ray.
[Claim 2] Irradiate an excitation energy beam and the plasma is made to form in the target member in the decompressed vacuum housing. In the X-ray generator which uses a buffer gas in order to prevent the scattering particle which is the X-ray generator which takes out an X-ray from this plasma, and is emitted from said target member and/or said plasma It is the member which has opening which said excitation energy beam passes, and another opening which said X-ray passes. The X-ray generator characterized by preparing a scattering particle inhibition member in the solid angle field equivalent to the range which prepares the scattering particle electric shielding member which covers the scattering particle emitted from said target member and/or said plasma near said target member and the plasma, and takes out said X-ray.
[Claim 3] Said scattering particle electric shielding member is an X-ray generator according to claim 1 or 2 characterized by having a wrap configuration for all the emission range of said scattering particle, or the emission range of all abbreviation.
[Claim 4] The X-ray generator according to claim 1 to 3 characterized by preparing opening for exhaust air in said scattering particle electric shielding member.
[Claim 5] The X-ray generator according to claim 1 to 4 characterized by preparing opening for gas installation in said scattering particle electric shielding member.
[Claim 6] The X-ray generator according to claim 1 to 5 characterized by preparing further the scattering particle control-section material which it is [material] the scattering particle control-section material which controls direction distribution of the burst size of the scattering particle emitted from said target member and/or said plasma, and reduces the burst size of the scattering particle to the direction which takes out said X-ray.
[Claim 7] The X-ray generator according to claim 1 to 6 characterized by establishing further a cooling means to cool said scattering particle inhibition member.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the X-ray generator used for X-ray plants, such as an X-ray aligner, an X-ray microscope, and an X-rays spectroscopic analyzer.
[0002]
[Description of the Prior Art] If the target member placed into the vacuum housing which had laser light (an example of an excitation energy beam) decompressed is condensed and irradiated, a target member is plasma-ized quickly and what an X-ray with very high brightness is radiated for from this plasma (an X-ray is generated) (emission) is known (for example, such an X-ray generation source is called LPX:Laser-Plasma X-raysource).
[0003] With generating of an X-ray, from said plasma, the scattering particles (for example, the gasified ingredient, the ionized ingredient, an ingredient wafer, etc.) of a member ingredient are emitted from said target member, and scattering particles, such as a high-speed electron and ion, disperse in a vacuum housing from it again (these are hereafter called a scattering particle collectively). Since such a scattering particle collided with the clarification optical surface (for example, X-ray optics component side), adhered, was deposited, and the function and the property were reduced or it was changed [**** / damaging these], it was a big problem.
[0004] In order to solve this trouble, he was trying for a scattering particle not to arrive at a clarification optical surface by the conventional approach by installing and covering the thin film (it being hereafter called the thin film for scattering particle inhibition, or an X-ray ejection filter) which consists of roentgenoparent high matter (for example, Be) between X line source and a clarification optical surface. being filled up with the gas of the low atomic number with the high permeability to an X-ray (for example, helium gas) in a vacuum housing as the other approaches -- or by forming the gas stream of this gas, the gas molecule was made to collide with a scattering particle, and inhibition of a scattering particle was aimed at (refer to JP,63-292553,A).
[0005]
[Problem(s) to be Solved by the Invention] There is a trouble that the rate of radioparency of the thin film for scattering particle inhibition falls gradually by installation of the thin film for scattering particle inhibition since a scattering particle adheres and deposits on the thin film for scattering particle inhibition although adhesion of the scattering particle to a clarification optical surface and deposition can be prevented instead (the use X-ray intensity in the direction of X-ray ejection falls).
[0006] Moreover, by the approach of aiming at inhibition of a scattering particle, there is a trouble that a scattering particle cannot necessarily be prevented effectively, by [which are filled up with the gas of a low atomic number with the high transmission to an X-ray (buffer gas) in a vacuum housing] depending especially or forming the gas stream of this gas. For example, when a target member is a tantalum, within the fully exhausted vacuum housing (pressure of 10Pa or less), many scattering particles in the direction of a normal of a target member front face are distributed. And although a scattering particle will decrease about the direction where many scattering particles are emitted for dispersion by the gas molecule if the buffer gas for scattering particle inhibition is introduced in a vacuum housing, the scattered scattering particles disperse before gas installation also in the direction which had little emission of a scattering particle.
[0007] Therefore, if a buffer gas is used in order to prevent a scattering particle, distribution of the emission direction of a scattering particle will be equalized. About the direction with little emission of a scattering particle, as compared with the direction with much emission of a scattering particle, this has the small effectiveness of gas installation, or shows that it becomes an opposite effect rather. As for the ejection of an X-ray, it is common to carry out in a direction with little emission of a scattering particle, and the effectiveness of gas installation is small about the direction of ejection of an X-ray with little emission of a scattering particle, or it is a big trouble to become an opposite effect rather.
[0008] When preparing the scattering particle control-section material which it is [material] the scattering particle control-section material which controls direction distribution of the burst size of a scattering particle near the plasma especially, and reduces the burst size of the scattering particle to the direction which takes out said X-ray, the effectiveness of the gas installation about the direction of ejection of an X-ray is small, or it is a big trouble to become an opposite effect rather. This invention is an X-ray generator which uses a buffer gas, in order to have been made in view of this trouble and to prevent a scattering particle, and it aims at offering the X-ray generator which can use about the direction of ejection of an X-ray, reducing adhesion of an inconvenient scattering particle and deposition, consequently carrying out long duration stability.
[0009]
[Means for Solving the Problem] Irradiate an excitation energy beam at the target member in the decompressed vacuum housing, and the plasma is made to form. therefore, this invention -- the first -- "-- In the X-ray generator which uses a buffer gas in order to prevent the scattering particle which is the X-ray generator which takes out an X-ray from this plasma, and is emitted from said target member and/or said plasma It is the member which has opening which said excitation energy beam passes, and another opening which said X-ray passes. The scattering particle electric shielding member which covers the scattering particle emitted from said target member and/or said plasma is prepared near said target member and the plasma. And the X-ray

generator (claim 1) characterized by preparing the scattering particle inhibition member which adjoins or approaches in the solid angle field equivalent to the range which takes out said X-ray" is offered.
[0010] Irradiate an excitation energy beam at the target member in the decompressed vacuum housing, and the plasma is made to form. moreover, this invention -- the second -- "-- In the X-ray generator which uses a buffer gas in order to prevent the scattering particle which is the X-ray generator which takes out an X-ray from this plasma, and is emitted from said target member and/or said plasma It is the member which has opening which said excitation energy beam passes, and another opening which said X-ray passes. The scattering particle electric shielding member which covers the scattering particle emitted from said target member and/or said plasma is prepared near said target member and the plasma. And the X-ray generator (claim 2) characterized by preparing a scattering particle inhibition member in the solid angle field equivalent to the range which takes out said X-ray" is offered.
[0011] Moreover, this invention provides the third with "the X-ray generator (claim 3) according to claim 1 or 2 characterized by said scattering particle electric shielding member having a wrap configuration for all the emission range of said scattering particle, or the emission range of all abbreviation." Moreover, this invention provides the fourth with "the X-ray generator (claim 4) according to claim 1 to 3 characterized by preparing opening for exhaust air in said scattering particle electric shielding member."
[0012] Moreover, this invention provides the fifth with "the X-ray generator (claim 5) according to claim 1 to 4 characterized by preparing opening for gas installation in said scattering particle electric shielding member." Moreover, this invention provides the sixth with "the X-ray generator (claim 6) according to claim 1 to 5 characterized by preparing further the scattering particle control-section material which it is [material] the scattering particle control-section material which controls direction distribution of the burst size of the scattering particle emitted from said target member and/or said plasma, and reduces the burst size of the scattering particle to the direction which takes out said X-ray."
[0013] Moreover, this invention provides the seventh with "the X-ray generator (claim 7) according to claim 1 to 6 characterized by establishing further a cooling means to cool said scattering particle inhibition member."
[0014]
[Function] In the X-ray generator of this invention, opening which prepares the scattering particle electric shielding member which covers the scattering particle emitted from a target member and/or the plasma near a target member and the plasma, and an excitation energy beam passes to this scattering particle electric shielding member, and another opening which an X-ray passes are prepared.
[0015] Therefore, without decreasing the reinforcement of the X-ray generated from X line source, the burst size of the scattering particle to inconvenient directions (the direction which faces to the thin film for scattering particle inhibition, direction which goes to a clarification optical surface) is reduced, and adhesion of an inconvenient scattering particle and deposition (adhesion to the thin film for scattering particle inhibition, a clarification optical surface, etc., deposition) can be reduced. Furthermore, in the X-ray generator of this invention, the scattering particle inhibition member located the outside (field which adjoins or approaches) or inside a solid angle field is prepared. [equivalent to the range which takes out an X-ray]
[0016] Therefore, adhesion of an inconvenient scattering particle and deposition (adhesion to the thin film for scattering particle inhibition, a clarification optical surface, etc., deposition) can be reduced about the direction of ejection of an X-ray. Therefore, according to the X-ray generator of this invention, long duration stability is carried out and an X-ray generator can be used (claims 1 and 2). Arrangement of each part material which starts the X-ray generator (an example) of this invention at drawing 1 is shown.
[0017] The excitation energy beam 111 goes in the direction of X-ray ejection through another opening B which formed X-ray 112 generated from the plasma 113 toward the target member 114 through the opening A prepared in the scattering particle electric shielding member 101 in the scattering particle electric shielding member 101. Therefore, the reinforcement of the X-ray generated from X line source (plasma) does not decrease.
[0018] It reflects, and most scattering particles emitted from the target member 114 and/or the plasma 113 are collided and scattered on the scattering particle electric shielding member 101. These scattering particles reflected and scattered about collide with the scattering particle which goes to the opening B prepared in the scattering particle electric shielding member 101, and change the scattering direction. Therefore, originally the scattering particle which should pass Opening B can pass Opening B.
[0019] Moreover, the probability for a scattering particle and a particle after colliding with the scattering particle reflected and scattered about and the scattering particle which goes to Opening B to pass Opening B is very small. Passing Opening B without receiving dispersion within the scattering particle electric shielding member 101, the scattering particle which jumped out of the plasma 113 in the solid angle field T which expects the X-ray ejection aperture (an example of a clarification optical surface) 123 receives dispersion by the buffer gas inside the scattering particle inhibition member 102. And there are very few particles which reach the X-ray ejection aperture 123 as a result of dispersion, passing only through the inside of the solid angle field T.
[0020] Since the structure inside the scattering particle inhibition member 102 has a configuration which prevents effectively the scattering particle which jumped out of the solid angle field T, it can reduce effectively the scattering particle adhered and deposited in the X-ray ejection aperture 123. It is not necessarily limited to a tabular object with puncturing like a member 102 that the scattering particle inhibition member concerning this invention should just have the configuration from which the scattering particle which came out of Field T can prevent advancing into Field T again.
[0021] Moreover, although the amount of X linear lights taken out strictly will fall, the aforementioned effectiveness is acquired even if it prepares a scattering particle inhibition member in the solid angle field T equivalent to the range which takes out an X-ray. For example, it is the case where a very thin plate is formed in accordance with an optical path on the optical path of the X-ray in a solid angle field. In addition, since the scattering particle emitted toward the outside of the solid angle field T which expects the X-ray ejection aperture 123 from the plasma 113 cannot trespass upon the interior of a member when the member 102 keeps airtightness perfect except for a part for the pore in which an X-ray carries out incidence, even when the member 101 is not arranged, it does not reach the X-ray ejection aperture 123 by dispersion.

[0022] However, also although it is called the space of the outside of a member 102, as for the consistency of a scattering particle, it is desirable to stop low and to prevent the dirt by the scattering particle in a vacuum housing. Moreover, the scattering grain density of the space of the outside of a member 102 is fully lowered by the member 101, and the way which does not require strict airtightness is easy for a member 102 in manufacture of these members, and adjustment of arrangement rather than it attains strict airtightness.
[0023] In order to ensure electric shielding of a scattering particle, it is desirable that a scattering particle electric shielding member makes a wrap configuration all the emission range of a scattering particle or the emission range of all abbreviation (claim 3). For example, the shape of dome shape and a core box configuration are desirable. The scattering particle from a target member etc. increases, the degree of vacuum between a target member and a scattering particle electric shielding member may worsen, and this becomes remarkable as the repeat frequency of excitation energy light (for example, pulse laser light) becomes high.
[0024] If the degree of vacuum between a target member and a scattering particle electric shielding member worsens, before excitation energy light reaches a target member, breakdown will be carried out, and the X-ray emitted from the plasma will be absorbed, and the problem that the X-ray intensity (it takes out) to be used falls will occur. Therefore, it is desirable to prepare opening for exhaust air in a scattering particle electric shielding member (claim 4). If piping from an exhauster is connected to opening for exhaust air and the space between a target member and a scattering particle electric shielding member is exhausted, since aggravation of said degree of vacuum can be prevented, the fall of X-ray intensity can also be prevented.
[0025] In addition, another opening which opening which an excitation energy beam passes, or an X-ray passes may be made to serve a double purpose as opening for exhaust air. Moreover, it is desirable to prepare opening for gas installation in a scattering particle electric shielding member (claim 5). If piping from the chemical cylinder besides a vacuum housing is connected to opening for gas installation and gas is introduced into the space between a target member and a scattering particle electric shielding member, since a scattering particle can be discharged outside said space by gas and aggravation of said degree of vacuum can be prevented, the fall of X-ray intensity can also be prevented.
[0026] in addition, the exhauster with which the gas and the scattering particle which were discharged outside said space exhaust the whole vacuum housing -- or it is discharged out of a vacuum housing by the exhauster linked to opening for said exhaust air. As for the gas to introduce, what has the few absorption to the X-ray of the wavelength (it takes out) to be used is desirable, for example, the absorption to the X-ray used [from] among gas, such as helium, oxygen, nitrogen, air, an argon, and a krypton, chooses few things, and should just introduce it.
[0027] As for the amount of installation of gas, it is desirable to make it extent from which the amount of X-ray absorptions by introductory gas in the space between a target member and a scattering particle electric shielding member does not pose a problem. If the scattering particle control-section material which it is [material] the scattering particle control-section material which controls direction distribution of the burst size of a scattering particle, and reduces the burst size of the scattering particle to the direction which takes out an X-ray is prepared further, since the scattering particle inhibition effectiveness in the direction of ejection of an X-ray will increase, it is desirable (claim 6).
[0028] As an ingredient used for this scattering particle control-section material, high-melting [, such as a tantalum, a tungsten, a diamond, a ceramic, and stainless steel,] or the ingredient of a high degree of hardness is desirable, for example. Since scattering particle control-section material is arranged in the location which approached the plasma very much, this is for preventing emission of this member ingredient by the collision to this member front face of ion or an electron that comes flying from the plasma. That is, since inconvenient adhesion and deposition will arise like a scattering particle if there is emission of this member ingredient, this is prevented.
[0029] If a cooling means to cool the scattering particle inhibition member concerning this invention is established further, since this member will become easy to adsorb a scattering particle and the inhibition effectiveness will increase, it is desirable (claim 7). Or it is also desirable to process the front face of a scattering particle inhibition member (for example, delustering processing) so that it may be easy to adsorb a scattering particle. although the configuration of the target member concerning this invention has the desirable shape especially of a tape which can be rolled round -- the shape of tabular and bulk -- being cylindrical . Moreover, the ingredient of a target member has Ta, desirable W, etc.
[0030] Hereafter, although an example explains this invention to a detail further, this invention is not limited to these examples.
[0031]
[Example] A tape-like tantalum is used for drawing 2 as a target member 214, and the partial block diagram of the X-ray generator of this example using an X-ray with a wavelength of 13nm is shown. It is condensed by the front face of the tantalum target 214 arranged in a vacuum housing 221, after it is condensed with a condenser lens 224 and the YAG laser light (an example of an excitation energy beam) 211 penetrates an entrance window 222.
[0032] The tantalum target 214 is a tape configuration with a thickness of 15 micrometers, at the time of plasma generating, by the driving means (for example, a motor, un-illustrating), rotates a reel 215 and is rolling round the tantalum tape so that laser light may not be repeatedly condensed by the same location on a tape. The passing speed of a tantalum tape is a rate which a tape moves beyond the distance equivalent to the diameter of the hole which will be produced on a tantalum tape with plasma generating by the time the laser light for generating the following plasma carries out incidence, after one plasma is generated.
[0033] X-ray 212 which generated YAG laser 211 in the incident angle of 45 degrees on the tantalum tape target 214 from incidence and the plasma 213 which it was condensed and was generated is led to an X-ray optics system in YAG laser 211 from the X-ray ejection aperture 223 prepared in the direction of 45 degrees of the opposite side. Near the plasma 213, the scattering particle electric shielding member 201 which has the opening A which YAG laser 211 which carries out incidence to a target 214 passes, and the opening B which X-ray 212 to take out passes is arranged.
[0034] If it applies to the X-ray ejection aperture 223 neighborhood from the opening B of a member 201, the scattering particle inhibition member 202 is arranged. The member 202 has the configuration which has arranged two or more plates 241,242,243 which the hole opened so that the field T of the solid angle which expects the X-ray ejection aperture 223 from the plasma 213 might not be interrupted. Kr gas is filled up into the vacuum housing 221 with the pressure of 0.1torr(s) as a buffer gas. Kr gas

has permeability comparable as helium of the same pressure to an X-ray with a wavelength of 13nm.
[0035] In the X-ray plant of this example, scattering particles other than the scattering particle which jumps out, respectively in the direction as for which YAG laser 211 carries out incidence, and the direction of X-ray 212 to take out are covered by the member 201. Therefore, the scattering particle weight diffused in a vacuum housing can be reduced by dispersion with the gas with which it filled up, and the scattering particle which reaches the X-ray ejection aperture 223 can be reduced. In addition, the contamination in the vacuum housing by the scattering particle is mitigable.
[0036] Moreover, a member 202 prevents what cannot pass the tabular part 241,242,243 which has a hole by dispersion with Kr gas molecule with which it filled up in the vacuum housing among the scattering particles which jumped out in the direction of ejection of an X-ray, and the scattering particle weight which reaches the X-ray ejection aperture 223 is decreased. Furthermore, the part which forms the outer shell of a member 202 can prevent a particle from scattering reaching [which was diffused in the vacuum housing (outside of a member 202)] the X-ray ejection aperture 223.
[0037] Kr gas with which it was filled up as a buffer gas can scatter a scattering particle very effectively compared with the gas of an element with the small mass numbers, such as helium gas. In this example, although each of incident angles of the YAG laser to a target member front face and ejection angles of an X-ray was made into 45 degrees, it is not limited to this include angle. Although the thing of a configuration like a member 202 was used as a scattering particle inhibition member in this example, the same effectiveness is acquired also by arranging the member 341 of the shape of a cone as shown in drawing 3 (the 2nd example).
[0038] Moreover, after fully reducing the scattering particle weight diffused in a vacuum housing by the scattering particle electric shielding members 401 and 501, as shown in drawing 4 , in the plate which has the configuration which the hole opened to the field through which an X-ray passes, two or more sheets are arranged, or as shown in (the 3rd example) and drawing 5 , the same effectiveness is acquired by one sheet or the thing (the 4th example) also for which one or more cone-like members are arranged.
[0039] According to the X-ray plant of this example, adhesion of an inconvenient scattering particle and deposition (adhesion to the thin film for scattering particle inhibition, a clarification optical surface, etc., deposition) can be reduced about the direction of ejection of an X-ray. That is, according to the X-ray generator of this invention, long duration stability is carried out and an X-ray generator can be used.
[0040]
[Effect of the Invention] According to the X-ray generator of this invention, since adhesion of an inconvenient scattering particle and deposition (adhesion to the thin film for scattering particle inhibition, a clarification optical surface, etc., deposition) can be reduced about the direction of ejection of an X-ray consequently, long duration stability is carried out and an X-ray generator can be used.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing arrangement of ** and each part material concerning the X-ray generator (an example) of this invention.
[Drawing 2] They are ** and the outline block diagram of the X-ray generator of the 1st example.
[Drawing 3] They are ** and the outline block diagram of the X-ray generator of the 2nd example.
[Drawing 4] They are ** and the outline block diagram of the X-ray generator of the 3rd example.
[Drawing 5] They are ** and the outline block diagram of the X-ray generator of the 4th example.
[Description of Notations in the Main Part]
101 201,301,401,501 Scattering particle electric shielding member
102,202 Scattering particle inhibition member
111 211,311,411,511 YAG laser light (an example of an excitation energy beam)
112 212,312,412,512 X-ray to take out
113 213,313,413,513 Plasma
114 214,314,414,514 Target (target member)
123 223,323,423,523 X-ray ejection aperture (an example of a clarification optical surface)
215,315,415,515 Reel
221,321,421,521 Vacuum housing
222,322,422,522 YAG laser light entrance window
224,324,424,524 Condenser lens
241,242,243 Plate-like part material which has puncturing (member which constitutes the scattering particle inhibition member 202)
441,442,443,444 Plate-like part material which has puncturing
341,541,542,543 Cone-like member
A Opening which YAG laser light passes
B Opening which the X-ray to take out passes
T The field through which the X-ray to take out passes (solid angle field)
with -- Top

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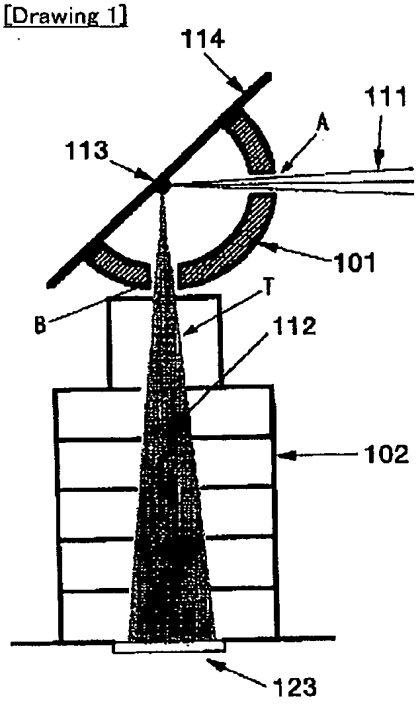
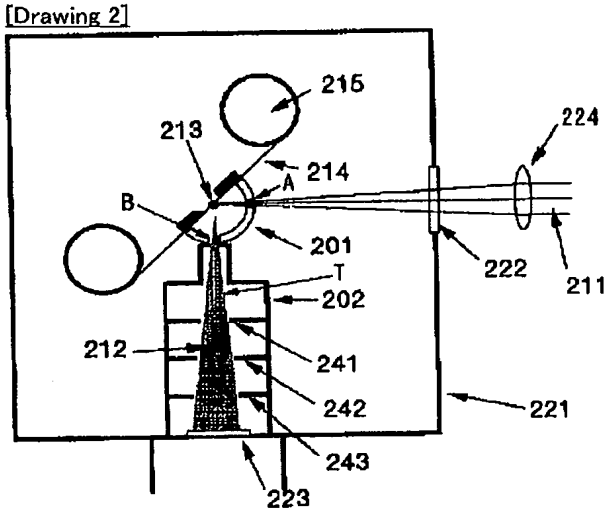
DRAWINGS

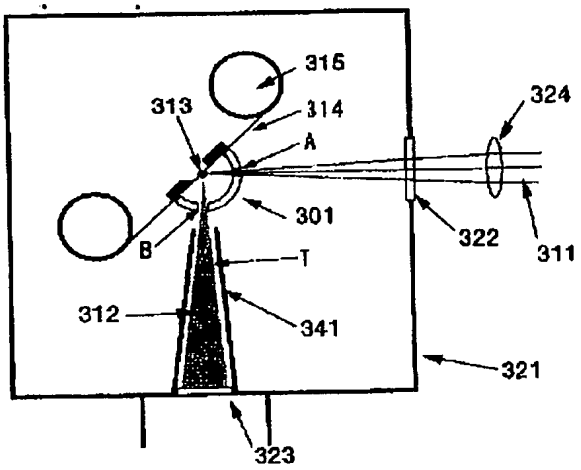
[Drawing 1]



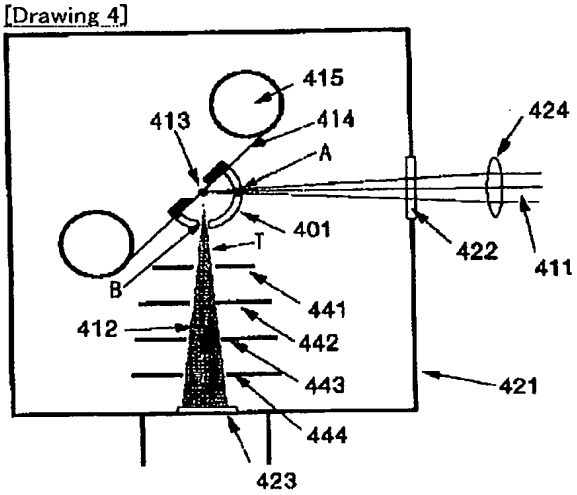
[Drawing 2]



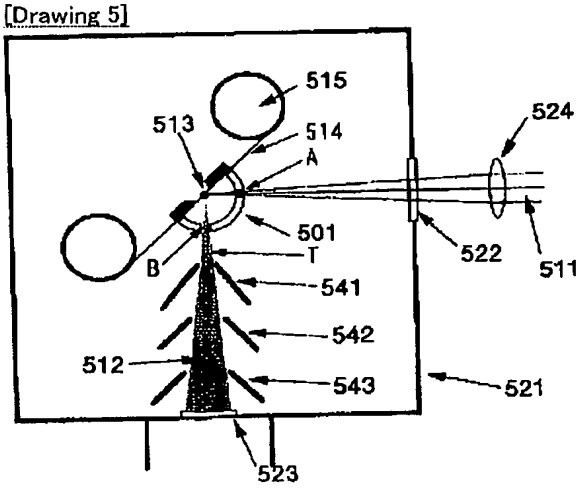
[Drawing 3]



[Drawing 4]



[Drawing 5]



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CORRECTION OR AMENDMENT

[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
[Section partition] The 1st partition of the 7th section
[Publication date] September 16, Heisei 16 (2004. 9.16)

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[The 7th edition of International Patent Classification]

H05G 2/00

[FI]

H05G 1/00 K

[Procedure revision]
[Filing Date] September 3, Heisei 15 (2003. 9.3)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] The name of invention
[Method of Amendment] Modification
[The contents of amendment]
[Title of the Invention] An X-ray generator and an X-ray aligner
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[The contents of amendment]
[Claim(s)]
[Claim 1]
An X-ray is taken out by plasma-izing a target member, and in order to prevent the scattering particle emitted, it is the X-ray generator which uses a buffer gas.
The X-ray generator characterized by preparing the scattering particle inhibition member which adjoins or approaches in the solid angle field equivalent to the range which is the member which has opening which said X-ray passes, and prepares the scattering particle electric shielding member which covers the scattering particle emitted from said target member and/or said plasma said target member and near the plasma, and takes out said X-ray.
[Claim 2]
An X-ray is taken out by plasma-izing a target member, and in order to prevent the scattering particle emitted, it is the X-ray generator which uses a buffer gas.
The X-ray generator characterized by preparing a scattering particle inhibition member in the solid angle field equivalent to the range which is the member which has opening which said X-ray passes, and prepares the scattering particle electric shielding member which covers the scattering particle emitted from said target member and/or said plasma said target member and near the plasma, and takes out said X-ray.
[Claim 3]
The X-ray generator according to claim 1 to 2 characterized by preparing further another opening which an exoitation energy beam passes to said scattering particle electric shielding member.
[Claim 4]
Said scattering particle electric shielding member is an X-ray generator according to claim 1 to 3 characterized by having a wrap configuration for all the emission range of said scattering particle, or the range of all abbreviation.
[Claim 5]
The X-ray generator according to claim 1 to 4 characterized by preparing opening for exhaust air in said scattering particle electric shielding member.
[Claim 6]
The X-ray generator according to claim 1 to 5 characterized by preparing opening for gas installation in said scattering particle

electric shielding member.
[Claim 7]
The X-ray generator according to claim 6 characterized by the gas introduced in said scattering particle electric shielding member containing helium, oxygen, nitrogen, air, an argon, or a krypton.
[Claim 8]
The X-ray generator according to claim 1 to 7 characterized by preparing further the scattering particle control-section material which it is [material] the scattering particle control-section material which controls direction distribution of the burst size of the scattering particle emitted from said target member and/or said plasma, and reduces the burst size of the scattering particle to the direction which takes out said X-ray.
[Claim 9]
The X-ray generator according to claim 8 characterized by the ingredient used for said scattering particle control-section material containing a tantalum, a tungsten, a diamond, a ceramic, and stainless either.
[Claim 10]
The X-ray generator according to claim 1 to 9 characterized by establishing further a means to cool said scattering particle inhibition member.
[Claim 11]
The X-ray aligner using an X-ray generator given in any 1 term of claims 1-10.
[Procedure amendment 3]
[Document to be Amended] Specification
[Item(s) to be Amended] 0001
[Method of Amendment] Modification
[The contents of amendment]
[0001]
[Field of the Invention] This invention relates to the X-ray generator used for X-ray plants, such as an X-ray aligner, an X-ray microscope, and an X-rays spectroscopic analyzer, and the X-ray aligner using it.
[Procedure amendment 4]
[Document to be Amended] Specification
[Item(s) to be Amended] 0009
[Method of Amendment] Modification
[The contents of amendment]
[0009]
[Means for Solving the Problem] Therefore, this invention takes out an X-ray by plasma-izing" target member in the first place. And it is the X-ray generator which uses a buffer gas in order to prevent the scattering particle emitted. Are the member which has opening which said X-ray passes, and the scattering particle electric shielding member which covers the scattering particle emitted from said target member and/or said plasma is prepared said target member and near the plasma. And the X-ray generator (claim 1) characterized by preparing the scattering particle inhibition member which adjoins or approaches in the solid angle field equivalent to the range which takes out said X-ray" is offered.
[Procedure amendment 5]
[Document to be Amended] Specification
[Item(s) to be Amended] 0010
[Method of Amendment] Modification
[The contents of amendment]
[0010]
Moreover, this invention takes out an X-ray by plasma-izing" target member to the second. And it is the X-ray generator which uses a buffer gas in order to prevent the scattering particle emitted. Are the member which has opening which said X-ray passes, and the scattering particle electric shielding member which covers the scattering particle emitted from said target member and/or said plasma is prepared said target member and near the plasma. And the X-ray generator characterized by preparing a scattering particle inhibition member in the solid angle field equivalent to the range which takes out said X-ray. (Claim 2)" -- it provides.
[Procedure amendment 6]
[Document to be Amended] Specification
[Item(s) to be Amended] 0011
[Method of Amendment] Modification
[The contents of amendment]
[0011]
Moreover, this invention provides the third with "the X-ray generator (claim 3) according to claim 1 to 2 characterized by preparing further another opening which an excitation energy beam passes to said scattering particle electric shielding member."
[Procedure amendment 7]
[Document to be Amended] Specification
[Item(s) to be Amended] 0012
[Method of Amendment] Modification
[The contents of amendment]
[0012]
Moreover, this invention provides the fourth with "the X-ray generator (claim 4) according to claim 1 to 3 characterized by said scattering particle electric shielding member having a wrap configuration for all the emission range of said scattering particle, or the range of all abbreviation." Moreover, this invention provides the fifth with "the X-ray generator (claim 5) according to claim 1

to 4 characterized by preparing opening for exhaust air in said scattering particle electric shielding member."
Moreover, this invention provides the sixth with "the X-ray generator (claim 6) according to claim 1 to 5 characterized by preparing opening for gas installation in said scattering particle electric shielding member."
[Procedure amendment 8]
[Document to be Amended] Specification
[Item(s) to be Amended] 0013
[Method of Amendment] Modification
[The contents of amendment]
[0013]
Moreover, this invention provides the seventh with "the X-ray generator (claim 7) according to claim 6 characterized by the gas introduced in said scattering particle electric shielding member containing helium, oxygen, nitrogen, air, an argon, or a krypton."
Moreover, this invention provides the eighth with "the X-ray generator (claim 8) according to claim 1 to 7 characterized by preparing further the scattering particle control-section material which it is [material] the scattering particle control-section material which controls direction distribution of the burst size of the scattering particle emitted from said target member and/or said plasma, and reduces the burst size of the scattering particle to the direction which takes out said X-ray."
Moreover, this invention provides the ninth with "the X-ray generator (claim 9) according to claim 8 characterized by the ingredient used for said scattering particle control-section material containing a tantalum, a tungsten, a diamond, a ceramic, and stainless either." Moreover, this invention provides the tenth with "the X-ray generator (claim 10) according to claim 1 to 9 characterized by establishing further a means to cool said scattering particle inhibition member." Moreover, this invention provides the eleventh with "the X-ray aligner (claim 11) using an X-ray generator given in any 1 term of claims 1-10."
[Procedure amendment 9]
[Document to be Amended] Specification
[Item(s) to be Amended] 0016
[Method of Amendment] Modification
[The contents of amendment]
[0016]
Therefore, adhesion of an inconvenient scattering particle and deposition (adhesion to the thin film for scattering particle inhibition, a clarification optical surface, etc., deposition) can be reduced about the direction of ejection of an X-ray. Therefore, according to the X-ray generator of this invention, long duration stability is carried out and an X-ray generator can be used. Arrangement of each part material which starts the X-ray generator (an example) of this invention at drawing 1 is shown.
[Procedure amendment 10]
[Document to be Amended] Specification
[Item(s) to be Amended] 0023
[Method of Amendment] Modification
[The contents of amendment]
[0023]
In order to ensure electric shielding of a scattering particle, as for a scattering particle electric shielding member, it is desirable to make all the emission range of a scattering particle or the emission range of all abbreviation into a wrap configuration. For example, the shape of dome shape and a core box configuration are desirable. The scattering particle from a target member etc. increases, the degree of vacuum between a target member and a scattering particle electric shielding member may worsen, and this becomes remarkable as the repeat frequency of excitation energy light (for example, pulse laser light) becomes high.
[Procedure amendment 11]
[Document to be Amended] Specification
[Item(s) to be Amended] 0024
[Method of Amendment] Modification
[The contents of amendment]
[0024]
If the degree of vacuum between a target member and a scattering particle electric shielding member worsens, before excitation energy light reaches a target member, breakdown will be carried out, and the X-ray emitted from the plasma will be absorbed, and the problem that the X-ray intensity (it takes out) to be used falls will occur. Therefore, it is desirable to prepare opening for exhaust air in a scattering particle electric shielding member. If piping from an exhauster is connected to opening for exhaust air and the space between a target member and a scattering particle electric shielding member is exhausted, since aggravation of said degree of vacuum can be prevented, the fall of X-ray intensity can also be prevented.
[Procedure amendment 12]
[Document to be Amended] Specification
[Item(s) to be Amended] 0025
[Method of Amendment] Modification
[The contents of amendment]
[0025]
In addition, another opening which opening which an excitation energy beam passes, or an X-ray passes may be made to serve a double purpose as opening for exhaust air. Moreover, it is desirable to prepare opening for gas installation in a scattering particle electric shielding member. If piping from the chemical cylinder besides a vacuum housing is connected to opening for gas installation and gas is introduced into the space between a target member and a scattering particle electric shielding member, since a scattering particle can be discharged outside said space by gas and aggravation of said degree of vacuum can be prevented, the fall of X-ray intensity can also be prevented.
[Procedure amendment 13]
[Document to be Amended] Specification

[Item(s) to be Amended] 0027
[Method of Amendment] Modification
[The contents of amendment]
[0027]
As for the amount of installation of gas, it is desirable to make it extent from which the amount of X-ray absorptions by introductory gas in the space between a target member and a scattering particle electric shielding member does not pose a problem. It is the scattering particle control-section material which controls direction distribution of the burst size of a scattering particle, and if the scattering particle control-section material which reduces the burst size of the scattering particle to the direction which takes out an X-ray is prepared further, since the scattering particle inhibition effectiveness in the direction of ejection of an X-ray will increase, it is desirable.
[Procedure amendment 14]
[Document to be Amended] Specification
[Item(s) to be Amended] 0029
[Method of Amendment] Modification
[The contents of amendment]
[0029]
If a cooling means to cool the scattering particle inhibition member concerning this invention is established further, since this member will become easy to adsorb a scattering particle and the inhibition effectiveness will increase, it is desirable. Or it is also desirable to process the front face of a scattering particle inhibition member (for example, delustering processing) so that it may be easy to adsorb a scattering particle. although the configuration of the target member concerning this invention has the desirable shape especially of a tape which can be rolled round -- the shape of tabular and bulk --- being cylindrical . Moreover, the ingredient of a target member has Ta, desirable W, etc.

[Translation done.]

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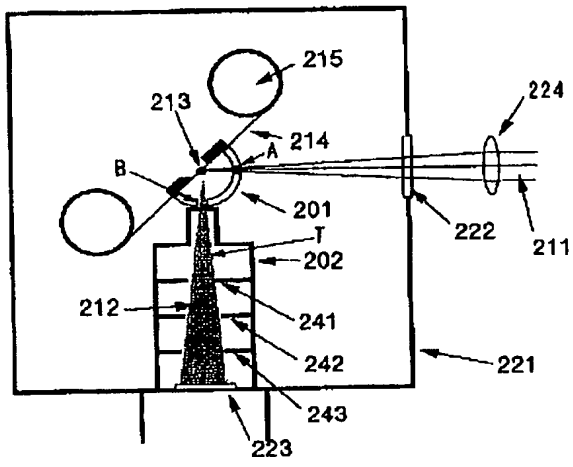
(54)【発明の名称】　Ｘ線発生装置

(57)【要約】

【課題】　飛散粒子を阻止するためにバッファガスを用いるＸ線発生装置であり、Ｘ線の取り出し方向について、不都合な飛散粒子の付着、堆積を低減して、その結果、長時間安定して使用できるＸ線発生装置を提供すること。

【解決手段】　減圧された真空容器２２１内の標的部材２１４に励起エネルギービームを２１１照射してプラズマ２１３を形成させ、該プラズマ２１３からＸ線２１２を取り出すＸ線発生装置であり、前記標的部材２１４及び／又は前記プラズマ２１３から放出される飛散粒子を阻止するためにバッファガスを用いるＸ線発生装置において、前記励起エネルギービーム２１１が通過する開口部Ａと前記Ｘ線２１２が通過する別の開口部Ｂを有する部材であり、前記標的部材２１４及び／又は前記プラズマ２１３から放出される飛散粒子を遮蔽する飛散粒子遮蔽部材２０１を前記標的部材２１４及びプラズマ２１３の近傍に設け、かつ、前記Ｘ線２１２を取り出す範囲に相当する立体角領域Ｔに隣接または近接する飛散粒子阻止部材２０２を設けたことを特徴とするＸ線発生装置。



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【特許請求の範囲】

【請求項１】　減圧された真空容器内の標的部材に励起エネルギービームを照射してプラズマを形成させ、該プラズマからＸ線を取り出すＸ線発生装置であり、前記標的部材及び／又は前記プラズマから放出される飛散粒子を阻止するためにバッファガスを用いるＸ線発生装置において、

前記励起エネルギービームが通過する開口部と前記Ｘ線が通過する別の開口部を有する部材であり、前記標的部材及び／又は前記プラズマから放出される飛散粒子を遮蔽する飛散粒子遮蔽部材を前記標的部材及びプラズマの近傍に設け、かつ、前記Ｘ線を取り出す範囲に相当する立体角領域に隣接または近接する飛散粒子阻止部材を設けたことを特徴とするＸ線発生装置。

【請求項２】　減圧された真空容器内の標的部材に励起エネルギービームを照射してプラズマを形成させ、該プラズマからＸ線を取り出すＸ線発生装置であり、前記標的部材及び／又は前記プラズマから放出される飛散粒子を阻止するためにバッファガスを用いるＸ線発生装置において、

前記励起エネルギービームが通過する開口部と前記Ｘ線が通過する別の開口部を有する部材であり、前記標的部材及び／又は前記プラズマから放出される飛散粒子を遮蔽する飛散粒子遮蔽部材を前記標的部材及びプラズマの近傍に設け、かつ、前記Ｘ線を取り出す範囲に相当する立体角領域内に飛散粒子阻止部材を設けたことを特徴とするＸ線発生装置。

【請求項３】　前記飛散粒子遮蔽部材は、前記飛散粒子の全放出範囲または略全ての放出範囲を覆う形状を有することを特徴とする請求項１または２記載のＸ線発生装置。

【請求項４】　前記飛散粒子遮蔽部材に排気用の開口部を設けたことを特徴とする請求項１～３記載のＸ線発生装置。

【請求項５】　前記飛散粒子遮蔽部材にガス導入用の開口部を設けたことを特徴とする請求項１～４記載のＸ線発生装置。

【請求項６】　前記標的部材及び／又は前記プラズマから放出される飛散粒子の放出量の方向分布を制御する飛散粒子制御部材であり、前記Ｘ線を取り出す方向への飛散粒子の放出量を低減させる飛散粒子制御部材をさらに設けたことを特徴とする請求項１～５記載のＸ線発生装置。

【請求項７】　前記飛散粒子阻止部材を冷却する冷却手段をさらに設けたことを特徴とする請求項１～６記載のＸ線発生装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、Ｘ線露光装置、Ｘ線顕微鏡、Ｘ線分析装置などのＸ線装置に用いられるＸ線発生装置に関するものである。

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【０００２】

【従来の技術】レーザー光（励起エネルギービームの一例）を減圧された真空容器内に置かれた標的部材に集光して照射すると、標的部材は急速にプラズマ化し、このプラズマから非常に輝度の高いＸ線が輻射（放出）される（Ｘ線を発生する）ことが知られている（例えば、このようなＸ線発生源はＬＰＸ：Laser-Plasma X-raysource と呼ばれる）。

【０００３】Ｘ線の発生と共に、前記プラズマからは高速の電子やイオン等の飛散粒子が、また前記標的部材からは部材材料の飛散粒子（例えば、ガス化した材料、イオン化した材料、材料小片など）が放出されて真空容器内に飛散する（以下、これらをまとめて飛散粒子と呼ぶ）。このような飛散粒子は、清浄光学面（例えば、Ｘ線光学素子面）に衝突して、これらを破損したり、或いは付着、堆積して機能や特性を低下させたり変化させるので、大きな問題であった。

【０００４】この問題点を解決するために従来の方法では、Ｘ線源と清浄光学面との間に、Ｘ線透過性の高い物質（例えば、Ｂｃ）からなる薄膜（以下、飛散粒子阻止用薄膜またはＸ線取り出しフィルターと呼ぶ）を設置して遮蔽することにより、飛散粒子が清浄光学面に到達しないようにしていた。その他の方法としては、真空容器内にＸ線に対する透過率の高い低原子番号のガス（例えば、Ｈｅガス）を充填することにより、或いは該ガスのガス流を形成することにより、飛散粒子にガス分子を衝突させて飛散粒子の阻止を図っていた（特開昭63-292553 参照）。

【０００５】

【発明が解決しようとする課題】飛散粒子阻止用薄膜の設置により、清浄光学面への飛散粒子の付着、堆積は防げるが、そのかわり、飛散粒子阻止用薄膜上に飛散粒子が付着、堆積するので、飛散粒子阻止用薄膜のＸ線透過率が次第に低下する（Ｘ線取り出し方向における使用Ｘ線強度が低下する）という問題点がある。

【０００６】また、真空容器内にＸ線に対する透過率の高い低原子番号のガス（バッファガス）を充填することにより、或いは該ガスのガス流を形成することにより、飛散粒子の阻止を図る方法では、必ずしも飛散粒子を有効に阻止できるわけではないという問題点がある。例えば、標的部材がタンタルである場合に、十分に排気された（圧力１０Ｐａ以下）真空容器内では、飛散粒子は標的部材表面の法線方向に多く分布する。そして、真空容器内に飛散粒子阻止用のバッファガスを導入すると、飛散粒子が多く放出される方向については、ガス分子による散乱のために飛散粒子は減少するが、散乱した飛散粒子はガス導入前には飛散粒子の放出が少なかった方向にも飛散する。

【０００７】そのため、飛散粒子を阻止するためにバッ

ファガスを使用すると、飛散粒子の放出方向の分布が均一化される。このことは、飛散粒子の放出が少ない方向については、飛散粒子の放出が多い方向と比較してガス導入の効果が小さいか、むしろ逆効果となることを示している。Ｘ線の取り出しは、飛散粒子の放出が少ない方向において行うのが一般的であり、飛散粒子の放出が少ないＸ線の取り出し方向について、ガス導入の効果が小さいか、むしろ逆効果となることは大きな問題点である。

【０００８】特に、プラズマ近傍に飛散粒子の放出量の方向分布を制御する飛散粒子制御部材であり、前記Ｘ線を取り出す方向への飛散粒子の放出量を低減させる飛散粒子制御部材を設ける場合に、Ｘ線の取り出し方向について、ガス導入の効果が小さいか、むしろ逆効果となることは大きな問題点である。本発明は、かかる問題点に鑑みてなされたもので、飛散粒子を阻止するためにバッファガスを用いるＸ線発生装置であり、Ｘ線の取り出し方向について、不都合な飛散粒子の付着、堆積を低減して、その結果、長時間安定して使用できるＸ線発生装置を提供することを目的とする。

【０００９】

【課題を解決する為の手段】そのため、本発明は第一に「減圧された真空容器内の標的部材に励起エネルギービームを照射してプラズマを形成させ、該プラズマからＸ線を取り出すＸ線発生装置であり、前記標的部材及び／又は前記プラズマから放出される飛散粒子を阻止するためにバッファガスを用いるＸ線発生装置において、前記励起エネルギービームが通過する開口部と前記Ｘ線が通過する別の開口部を有する部材であり、前記標的部材及び／又は前記プラズマから放出される飛散粒子を遮蔽する飛散粒子遮蔽部材を前記標的部材及びプラズマの近傍に設け、かつ、前記Ｘ線を取り出す範囲に相当する立体角領域に隣接または近接する飛散粒子阻止部材を設けたことを特徴とするＸ線発生装置（請求項１）」を提供する。

【００１０】また、本発明は第二に「減圧された真空容器内の標的部材に励起エネルギービームを照射してプラズマを形成させ、該プラズマからＸ線を取り出すＸ線発生装置であり、前記標的部材及び／又は前記プラズマから放出される飛散粒子を阻止するためにバッファガスを用いるＸ線発生装置において、前記励起エネルギービームが通過する開口部と前記Ｘ線が通過する別の開口部を有する部材であり、前記標的部材及び／又は前記プラズマから放出される飛散粒子を遮蔽する飛散粒子遮蔽部材を前記標的部材及びプラズマの近傍に設け、かつ、前記Ｘ線を取り出す範囲に相当する立体角領域内に飛散粒子阻止部材を設けたことを特徴とするＸ線発生装置（請求項２）」を提供する。

【００１１】また、本発明は第三に「前記飛散粒子遮蔽部材は、前記飛散粒子の全放出範囲または略全ての放出範囲を覆う形状を有することを特徴とする請求項１または２記載のＸ線発生装置（請求項３）」を提供する。また、本発明は第四に「前記飛散粒子遮蔽部材に排気用の開口部を設けたことを特徴とする請求項１～３記載のＸ線発生装置（請求項４）」を提供する。

【００１２】また、本発明は第五に「前記飛散粒子遮蔽部材にガス導入用の開口部を設けたことを特徴とする請求項１～４記載のＸ線発生装置（請求項５）」を提供する。また、本発明は第六に「前記標的部材及び／又は前記プラズマから放出される飛散粒子の放出量の方向分布を制御する飛散粒子制御部材であり、前記Ｘ線を取り出す方向への飛散粒子の放出量を低減させる飛散粒子制御部材をさらに設けたことを特徴とする請求項１～５記載のＸ線発生装置（請求項６）」を提供する。

【００１３】また、本発明は第七に「前記飛散粒子阻止部材を冷却する冷却手段をさらに設けたことを特徴とする請求項１～６記載のＸ線発生装置（請求項７）」を提供する。

【００１４】

【作用】本発明のＸ線発生装置においては、標的部材及び／又はプラズマから放出される飛散粒子を遮蔽する飛散粒子遮蔽部材を標的部材及びプラズマの近傍に設け、かつ該飛散粒子遮蔽部材に励起エネルギービームが通過する開口部とＸ線が通過する別の開口部を設けている。

【００１５】そのため、Ｘ線源から発生するＸ線の強度を減少させることなく、不都合な方向（飛散粒子阻止用薄膜に向かう方向や清浄光学面へ向かう方向など）への飛散粒子の放出量を低減させて、不都合な飛散粒子の付着、堆積（飛散粒子阻止用薄膜や清浄光学面などへの付着、堆積）を低減できる。さらに、本発明のＸ線発生装置においては、Ｘ線を取り出す範囲に相当する立体角領域の外側（隣接もしくは近接する領域）または内側に位置する飛散粒子阻止部材を設けている。

【００１６】そのため、Ｘ線の取り出し方向について、不都合な飛散粒子の付着、堆積（飛散粒子阻止用薄膜や清浄光学面などへの付着、堆積）を低減できる。従って、本発明のＸ線発生装置によれば、長時間安定してＸ線発生装置を使用できる（請求項１、２）。図１に本発明のＸ線発生装置（一例）にかかる各部材の配置を示す。

【００１７】励起エネルギービーム１１１は、飛散粒子遮蔽部材１０１に設けた開口部Ａを通って標的部材１１４に向かい、またプラズマ１１３から発生したＸ線１１２は、飛散粒子遮蔽部材１０１に設けた別の開口部Ｂを通ってＸ線取り出し方向に向かう。従って、Ｘ線源（プラズマ）から発生するＸ線の強度が減少することはない。

【００１８】標的部材１１４及び／又はプラズマ１１３から放出された飛散粒子の殆どは、飛散粒子遮蔽部材１０１に衝突して反射、散乱される。これらの反射、散乱

された飛散粒子は、飛散粒子遮蔽部材１０１に設けた開口部Ｂに向かう飛散粒子に衝突して、その飛散方向を変化させる。そのため、本来、開口部Ｂを通過するはずの飛散粒子は、開口部Ｂを通過できないことになる。

【００１９】また、反射、散乱された飛散粒子、開口部Ｂに向かう飛散粒子に衝突した後の飛散粒子や微粒子が開口部Ｂを通過する確率は極めて小さい。飛散粒子遮蔽部材１０１内で散乱を受けずに開口部Ｂを通過して、プラズマ１１３からＸ線取り出し窓（清浄光学面の一例）１２３を見込む立体角領域Ｔ内に飛びだした飛散粒子は、飛散粒子阻止部材１０２の内部でバッファガスによる散乱を受ける。そして、散乱の結果、立体角領域Ｔ内だけを通過しながらＸ線取り出し窓１２３に到達する粒子は極めて少ない。

【００２０】飛散粒子阻止部材１０２の内部の構造は、立体角領域Ｔから外に飛びだした飛散粒子を効果的に阻止するような形状を有しているので、Ｘ線取り出し窓１２３に付着・堆積する飛散粒子を効果的に低減することができる。本発明にかかる飛散粒子阻止部材は、領域Ｔの外に出た飛散粒子が再度領域Ｔ内に進入するのを阻止できる形状を有すればよく、部材１０２のような開孔付きの板状の物に限定されるわけではない。

【００２１】また、厳密には取り出すＸ線光量が低下することになるが、Ｘ線を取り出す範囲に相当する立体角領域Ｔ内に飛散粒子阻止部材を設けても、前記の効果が得られる。例えば、立体角領域内にあるＸ線の光路上に非常に薄い板を光路に沿って設ける場合である。なお、プラズマ１１３からＸ線取り出し窓１２３を見込む立体角領域Ｔ外に向かって放出された飛散粒子は、部材１０２がＸ線の入射する孔部分を除いて完全に気密性を保っている場合には部材の内部に侵入することはできないため、部材１０１が配置されていない場合でも、散乱によってＸ線取り出し窓１２３に到達することはない。

【００２２】しかし、部材１０２の外側の空間といえども、飛散粒子の密度は低く抑え、真空容器内の飛散粒子による汚れを防ぐことが望ましい。また、厳密な気密性を達成するよりも、部材１０１によって部材１０２の外側の空間の飛散粒子密度を十分に下げ、部材１０２には厳密な気密性を要求しないほうが、これらの部材の製作と配置の調整にあたっては容易である。

【００２３】飛散粒子の遮蔽を確実に行うために、飛散粒子遮蔽部材は、飛散粒子の全放出範囲または略全ての放出範囲を覆う形状にすることが好ましい（請求項３）。例えば、ドーム形状や箱型形状が好ましい。標的部材等からの飛散粒子が増大して、標的部材と飛散粒子遮蔽部材との間の真空度が悪くなることがあり、これは励起エネルギー光（例えば、パルスレーザー光）の繰り返し周波数が高くなるにつれて顕著となる。

【００２４】標的部材と飛散粒子遮蔽部材との間の真空度が悪くなると、励起エネルギー光が標的部材に到達する前にブレークダウンしたり、またプラズマから放出されるＸ線が吸収されて、使用する（取り出す）Ｘ線強度が低下するという問題が発生する。従って、飛散粒子遮蔽部材に排気用の開口部を設けることが好ましい（請求項４）。排気用の開口部に排気装置からの配管を接続して、標的部材と飛散粒子遮蔽部材との間の空間を排気すれば、前記真空度の悪化を防ぐことができるので、Ｘ線強度の低下も防ぐことができる。

【００２５】なお、励起エネルギービームが通過する開口部またはＸ線が通過する別の開口部を排気用の開口部として兼用してもよい。また、飛散粒子遮蔽部材にガス導入用の開口部を設けることが好ましい（請求項５）。ガス導入用の開口部に真空容器外のガスボンベからの配管を接続して、標的部材と飛散粒子遮蔽部材との間の空間にガスを導入すれば、ガスにより飛散粒子を前記空間外に排出して、前記真空度の悪化を防ぐことができるので、Ｘ線強度の低下も防ぐことができる。

【００２６】なお、前記空間外に排出されたガス及び飛散粒子は、真空容器全体を排気する排気装置により、或いは前記排気用の開口部に接続した排気装置により真空容器外に排出される。導入するガスは、利用する（取り出す）波長のＸ線に対する吸収が少ないものが好ましく、例えば、ヘリウム、酸素、チッ素、空気、アルゴン、クリプトンなどのガスのうちから、利用するＸ線に対する吸収が少ないものを選択して導入すればよい。

【００２７】ガスの導入量は、標的部材と飛散粒子遮蔽部材との間の空間における、導入ガスによるＸ線吸収量が問題とならない程度にすることが好ましい。飛散粒子の放出量の方向分布を制御する飛散粒子制御部材であり、Ｘ線を取り出す方向への飛散粒子の放出量を低減させる飛散粒子制御部材をさらに設けると、Ｘ線の取り出し方向における飛散粒子阻止効果が増大するので好ましい（請求項６）。

【００２８】かかる飛散粒子制御部材に用いる材料としては、例えば、タンタル、タングステン、ダイヤモンド、セラミック、ステンレスなどの高融点、又は高硬度の材料が好ましい。これは、飛散粒子制御部材がプラズマに非常に近接した位置に配置されるので、プラズマから飛来するイオンや電子の該部材表面への衝突による該部材材料の放出を防止するためである。即ち、該部材材料の放出があると飛散粒子と同様に不都合な付着、堆積が生じるので、これを防止するのである。

【００２９】本発明にかかる飛散粒子阻止部材を冷却する冷却手段をさらに設けると、該部材が飛散粒子を吸着しやすくなって、阻止効果が増大するので好ましい（請求項７）。或いは、飛散粒子を吸着しやすいように、飛散粒子阻止部材の表面を加工（例えば、つや消し加工）することも好ましい。本発明にかかる標的部材の形状は、巻き取り可能なテープ状が特に好ましいが板状、バルク状、円柱状でもよい。また、標的部材の材料は、Ｔ

a，Wなどが好ましい。

【００３０】以下、本発明を実施例により更に詳細に説明するが、本発明はこれらの実施例に限定されるものではない。

【００３１】

【実施例】図２に標的部材２１４としてテープ状のタンタルを用い、波長１３ｎｍのＸ線を利用する本実施例のＸ線発生装置の部分構成図を示す。ＹＡＧレーザー光（励起エネルギービームの一例）２１１が集光レンズ２２４により集光され、入射窓２２２を透過した後、真空容器２２１内に配置されたタンタルターゲット２１４の表面に集光される。

【００３２】タンタルターゲット２１４は厚さ１５μｍのテープ形状であり、テープ上の同じ位置にレーザー光が繰り返し集光されることのないように、プラズマ発生時には、駆動手段（例えば、モーター、不図示）により、リール２１５を回転させてタンタルテープを巻き取っている。タンタルテープの移動速度は、一つのプラズマが生成されてから次のプラズマを生成するためのレーザー光が入射するまでに、プラズマ発生に伴ってタンタルテープに生ずる孔の直径に相当する距離以上にテープが移動する速度である。

【００３３】ＹＡＧレーザー２１１は、タンタルテーターゲット２１４上に４５度の入射角で入射、集光され、生成したプラズマ２１３から発生したＸ線２１２は、ＹＡＧレーザー２１１とは反対側の４５度の方向に設けられたＸ線取り出し窓２２３からＸ線光学系へと導かれる。プラズマ２１３の近傍には、ターゲット２１４に入射するＹＡＧレーザー２１１が通過する開口Ａと取り出すＸ線２１２が通過する開口Ｂを有する飛散粒子遮蔽部材２０１が配置されている。

【００３４】部材２０１の開口ＢからＸ線取り出し窓２２３付近にかけては、飛散粒子阻止部材２０２が配置されている。部材２０２は、プラズマ２１３からＸ線取り出し窓２２３を見込む立体角の領域Ｔを遮らないように孔の開いた板２４１，２４２，２４３を複数配置した形状を有している。真空容器２２１には、バッファガスとしてＫｒガスが0.1torrの圧力で充填されている。Ｋｒガスは、波長１３ｎｍのＸ線に対して、同じ圧力のＨｅと同程度の透過率を有する。

【００３５】本実施例のＸ線装置では、ＹＡＧレーザー２１１が入射する方向と、取り出すＸ線２１２の方向にそれぞれ飛び出す飛散粒子以外の飛散粒子が部材２０１により遮蔽される。そのため、充填されたガスとの散乱により、真空容器内に拡散する飛散粒子量を低減し、Ｘ線取り出し窓２２３に到達する飛散粒子を低減することができる。加えて、飛散粒子による真空容器内の汚染を軽減することができる。

【００３６】また、部材２０２は、Ｘ線の取り出し方向に飛び出した飛散粒子のうち、真空容器内に充填されたＫｒガス分子との散乱により孔を有する板状の部分２４１，２４２，２４３を通過できないものを阻止して、Ｘ線取り出し窓２２３に到達する飛散粒子量を減少させる。さらに、部材２０２の外殻を形成している部分は、真空容器内（部材２０２の外側）に拡散した飛散粒子がＸ線取り出し窓２２３に到達するのを妨げることができる。

【００３７】バッファガスとして充填したＫｒガスは、Ｈｅガスなどの質量数の小さい元素のガスに比べると、非常に効果的に飛散粒子を散乱させることができる。本実施例では、標的部材表面へのＹＡＧレーザーの入射角と、Ｘ線の取り出し角をいずれも４５度としたが、この角度に限定されるものではない。本実施例では飛散粒子阻止部材として、部材２０２のような形状のものを用いたが、図３に示すようなコーン状の部材３４１を配置することによっても同様の効果が得られる（第２実施例）。

【００３８】また、飛散粒子遮蔽部材４０１、５０１により真空容器内に拡散する飛散粒子量を十分に低減した上で、図４に示すように、Ｘ線が通過する領域に孔の開いた形状を有する板を一枚あるいは複数枚配置したり（第３実施例）、図５に示すように、コーン状の部材を一つあるいは複数配置する（第４実施例）ことによっても同様の効果が得られる。

【００３９】本実施例のＸ線装置によれば、Ｘ線の取り出し方向について、不都合な飛散粒子の付着、堆積（飛散粒子阻止用薄膜や清浄光学面などへの付着、堆積）を低減できる。即ち、本発明のＸ線発生装置によれば、長時間安定してＸ線発生装置を使用できる。

【００４０】

【発明の効果】本発明のＸ線発生装置によれば、Ｘ線の取り出し方向について、不都合な飛散粒子の付着、堆積（飛散粒子阻止用薄膜や清浄光学面などへの付着、堆積）を低減できるので、その結果、長時間安定してＸ線発生装置を使用できる。

【図面の簡単な説明】

【図１】は、本発明のＸ線発生装置（一例）にかかる各部材の配置を示す図である。

【図２】は、第１実施例のＸ線発生装置の概略構成図である。

【図３】は、第２実施例のＸ線発生装置の概略構成図である。

【図４】は、第３実施例のＸ線発生装置の概略構成図である。

【図５】は、第４実施例のＸ線発生装置の概略構成図である。

【主要部分の符号の説明】

１０１，２０１，３０１，４０１，５０１　飛散粒子遮蔽部材

１０２，２０２　飛散粒子阻

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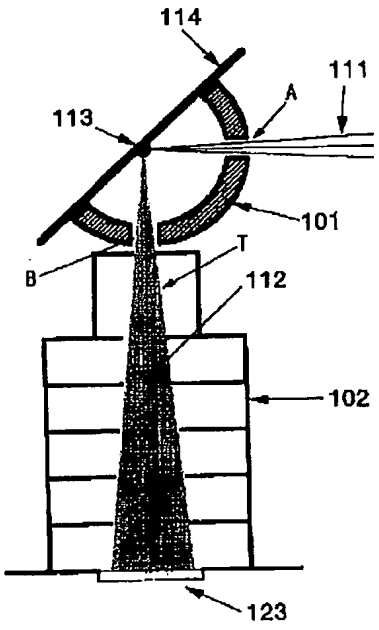
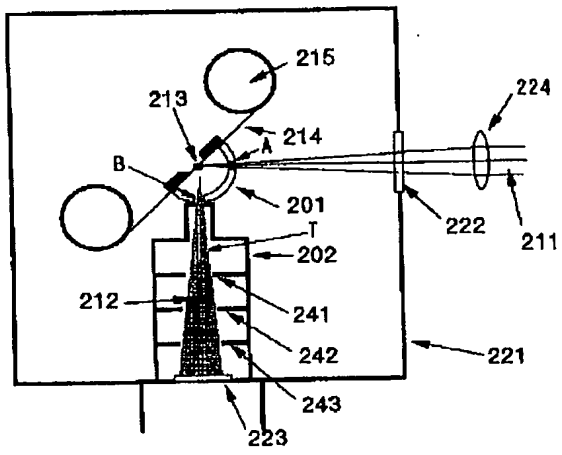
止部材
１１１，２１１，３１１，４１１，５１１　ＹＡＧレーザー光（励起エネルギービームの一例）
１１２，２１２，３１２，４１２，５１２　取り出すＸ線
１１３，２１３，３１３，４１３，５１３　プラズマ
１１４，２１４，３１４，４１４，５１４　ターゲット（標的部材）
１２３，２２３，３２３，４２３，５２３　Ｘ線取り出し窓（清浄光学面の一例）
２１５，３１５，４１５，５１５　リール
２２１，３２１，４２１，５２１　真空容器
２２２，３２２，４２２，５２２　ＹＡＧレーザー光入射窓
２２４，３２４，４２４，５２４　集光レンズ
２４１，２４２，２４３　開孔を有する板状部材（飛散粒子阻止部材２０２を構成する部材）
４４１，４４２，４４３，４４４　開孔を有する板状部材
３４１，５４１，５４２，５４３　コーン状部材
Ａ　ＹＡＧレーザー光が通過する開口
Ｂ　取り出すＸ線が通過する開口
Ｔ　取り出すＸ線が通過する領域（立体角領域）
以　上

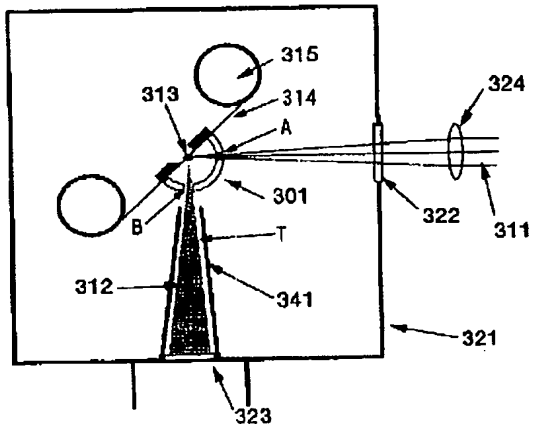
【図１】



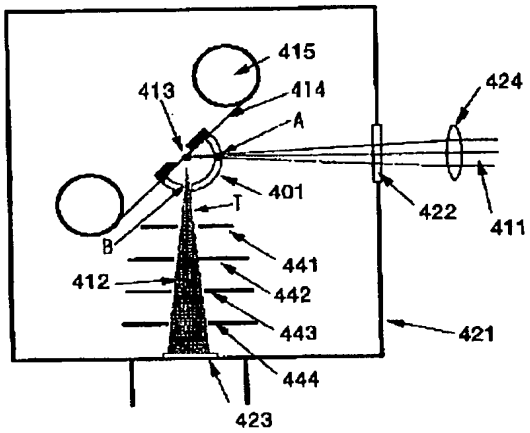
【図２】



【図３】



【図４】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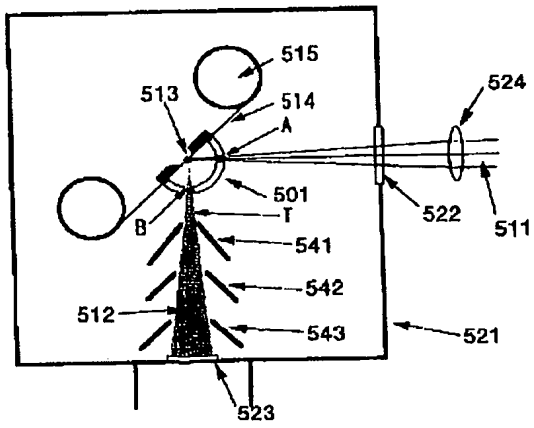
【図５】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【公報種別】特許法第１７条の２の規定による補正の掲載
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【ＦＩ】
ＨＯ５Ｇ　1/00　K

【手続補正書】
【提出日】平成15年9月3日(2003.9.3)
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】発明の名称
【補正方法】変更
【補正の内容】
【発明の名称】Ｘ線発生装置及びＸ線露光装置
【手続補正２】
【補正対象書類名】明細書
【補正対象項目名】特許請求の範囲
【補正方法】変更
【補正の内容】
【特許請求の範囲】
【請求項１】
標的部材をプラズマ化することによりＸ線を取り出し、かつ、放出される飛散粒子を阻止するためにバッファガスを用いるＸ線発生装置であって、
前記Ｘ線が通過する開口部を有する部材であり、前記標的部材及び／または前記プラズマから放出される飛散粒子を遮蔽する飛散粒子遮蔽部材を前記標的部材及びプラズマ近傍に設け、且つ、前記Ｘ線を取り出す範囲に相当する立体角領域に隣接または近接する飛散粒子阻止部材を設けた事を特徴とするＸ線発生装置。
【請求項２】
標的部材をプラズマ化することによりＸ線を取り出し、かつ、放出される飛散粒子を阻止するためにバッファガスを用いるＸ線発生装置であって、
前記Ｘ線が通過する開口部を有する部材であり、前記標的部材及び／または前記プラズマから放出される飛散粒子を遮蔽する飛散粒子遮蔽部材を前記標的部材及びプラズマ近傍に設け、且つ、前記Ｘ線を取り出す範囲に相当する立体角領域内に飛散粒子阻止部材を設けた事を特徴とするＸ線発生装置。
【請求項３】
前記飛散粒子遮蔽部材に励起エネルギービームが通過する別の開口部をさらに設けた事を特徴とする請求項１～２記載のＸ線発生装置。
【請求項４】
前記飛散粒子遮蔽部材は、前記飛散粒子の全放出範囲または略全ての範囲を覆う形状を有することを特徴とする請求項１～３記載のＸ線発生装置。
【請求項５】
前記飛散粒子遮蔽部材に排気用の開口部を設けたことを特徴とする請求項１～４記載のＸ線発生装置。
【請求項６】

前記飛散粒子遮蔽部材にガス導入用の開口部を設けたことを特徴とする請求項１～５記載のＸ線発生装置。
【請求項７】
前記飛散粒子遮蔽部材内に導入するガスがヘリウム、酸素、窒素、空気、アルゴン、クリプトンのいずれかを含むことを特徴とする請求項６記載のＸ線発生装置。
【請求項８】
前記標的部材及び／または前記プラズマから放出される飛散粒子の放出量の方向分布を制御する飛散粒子制御部材であり、前記Ｘ線を取り出す方向への飛散粒子の放出量を低減させる飛散粒子制御部材をさらに設けたことを特徴とする請求項１～７記載のＸ線発生装置。
【請求項９】
前記飛散粒子制御部材に用いる材料がタンタル、タングステン、ダイヤモンド、セラミック、ステンレスのいずれかを含むことを特徴とする請求項８記載のＸ線発生装置。
【請求項１０】
前記飛散粒子阻止部材を冷却する手段をさらに設けたことを特徴とする請求項１～９記載のＸ線発生装置。
【請求項１１】
請求項１～１０のいずれか１項に記載のＸ線発生装置を用いたＸ線露光装置。
【手続補正３】
【補正対象書類名】明細書
【補正対象項目名】０００１
【補正方法】変更
【補正の内容】
【０００１】
【発明の属する技術分野】本発明は、Ｘ線露光装置、Ｘ線顕微鏡、Ｘ線分析装置などのＸ線装置に用いられるＸ線発生装置及びそれを用いたＸ線露光装置に関するものである。
【手続補正４】
【補正対象書類名】明細書
【補正対象項目名】０００９
【補正方法】変更
【補正の内容】
【０００９】
【課題を解決する為の手段】そのため、本発明は第一に「標的部材をプラズマ化することによりＸ線を取り出し、かつ、放出される飛散粒子を阻止するためにバッファガスを用いるＸ線発生装置であって、前記Ｘ線が通過する開口部を有する部材であり、前記標的部材及び／または前記プラズマから放出される飛散粒子を遮蔽する飛散粒子遮蔽部材を前記標的部材及びプラズマ近傍に設け、且つ、前記Ｘ線を取り出す範囲に相当する立体角領域に隣接または近接する飛散粒子阻止部材を設けた事を特徴とするＸ線発生装置（請求項１）」を提供する。
【手続補正５】
【補正対象書類名】明細書
【補正対象項目名】００１０
【補正方法】変更
【補正の内容】
【００１０】
また、本発明は第二に「標的部材をプラズマ化することによりＸ線を取り出し、かつ、放出される飛散粒子を阻止するためにバッファガスを用いるＸ線発生装置であって、前記Ｘ線が通過する開口部を有する部材であり、前記標的部材及び／または前記プラズマから放出される飛散粒子を遮蔽する飛散粒子遮蔽部材を前記標的部材及びプラズマ近傍に設け、且つ、前記Ｘ線を取り出す範囲に相当する立体角領域内に飛散粒子阻止部材を設けた事を

特徴とするＸ線発生装置。（請求項２）」を提供する。
【手続補正６】
【補正対象書類名】明細書
【補正対象項目名】００１１
【補正方法】変更
【補正の内容】
【００１１】
また、本発明は第三に「前記飛散粒子遮蔽部材に励起エネルギービームが通過する別の開口部をさらに設けた事を特徴とする請求項１～２記載のＸ線発生装置（請求項３）」を提供する。
【手続補正７】
【補正対象書類名】明細書
【補正対象項目名】００１２
【補正方法】変更
【補正の内容】
【００１２】
また、本発明は第四に「前記飛散粒子遮蔽部材は、前記飛散粒子の全放出範囲または略全ての範囲を覆う形状を有することを特徴とする請求項１～３記載のＸ線発生装置（請求項４）」を提供する。また、本発明は第五に「前記飛散粒子遮蔽部材に排気用の開口部を設けたことを特徴とする請求項１～４記載のＸ線発生装置（請求項５）」を提供する。
また、本発明は第六に「前記飛散粒子遮蔽部材にガス導入用の開口部を設けたことを特徴とする請求項１～５記載のＸ線発生装置（請求項６）」を提供する。
【手続補正８】
【補正対象書類名】明細書
【補正対象項目名】００１３
【補正方法】変更
【補正の内容】
【００１３】
また、本発明は第七に「前記飛散粒子遮蔽部材内に導入するガスがヘリウム、酸素、窒素、空気、アルゴン、クリプトンのいずれかを含むことを特徴とする請求項６記載のＸ線発生装置（請求項７）」を提供する。また、本発明は第八に「前記標的部材及び／または前記プラズマから放出される飛散粒子の放出量の方向分布を制御する飛散粒子制御部材であり、前記Ｘ線を取り出す方向への飛散粒子の放出量を低減させる飛散粒子制御部材をさらに設けたことを特徴とする請求項１～７記載のＸ線発生装置（請求項８）」を提供する。
また、本発明は第九に「前記飛散粒子制御部材に用いる材料がタンタル、タングステン、ダイヤモンド、セラミック、ステンレスのいずれかを含むことを特徴とする請求項８記載のＸ線発生装置（請求項９）」を提供する。また、本発明は第十に「前記飛散粒子阻止部材を冷却する手段をさらに設けたことを特徴とする請求項１～９記載のＸ線発生装置（請求項１０）」を提供する。また、本発明は第十一に「請求項１～１０のいずれか１項に記載のＸ線発生装置を用いたＸ線露光装置（請求項１１）」を提供する。
【手続補正９】
【補正対象書類名】明細書
【補正対象項目名】００１６
【補正方法】変更
【補正の内容】
【００１６】
そのため、Ｘ線の取り出し方向について、不都合な飛散粒子の付着、堆積（飛散粒子阻止用薄膜や清浄光学面などへの付着、堆積）を低減できる。従って、本発明のＸ線発生装置によれば、長時間安定してＸ線発生装置を使用できる。図１に本発明のＸ線発生装置（一例）にかかる各部材の配置を示す。

【手続補正１０】
【補正対象書類名】明細書
【補正対象項目名】００２３
【補正方法】変更
【補正の内容】
【００２３】
飛散粒子の遮蔽を確実に行うために、飛散粒子遮蔽部材は、飛散粒子の全放出範囲または略全ての放出範囲を覆う形状にすることが好ましい。例えば、ドーム形状や箱型形状が好ましい。標的部材等からの飛散粒子が増大して、標的部材と飛散粒子遮蔽部材との間の真空度が悪くなることがあり、これは励起エネルギー光（例えば、パルスレーザー光）の繰り返し周波数が高くなるにつれて顕著となる。
【手続補正１１】
【補正対象書類名】明細書
【補正対象項目名】００２４
【補正方法】変更
【補正の内容】
【００２４】
標的部材と飛散粒子遮蔽部材との間の真空度が悪くなると、励起エネルギー光が標的部材に到達する前にブレークダウンしたり、またプラズマから放出されるＸ線が吸収されて、使用する（取り出す）Ｘ線強度が低下するという問題が発生する。従って、飛散粒子遮蔽部材に排気用の開口部を設けることが好ましい。排気用の開口部に排気装置からの配管を接続して、標的部材と飛散粒子遮蔽部材との間の空間を排気すれば、前記真空度の悪化を防ぐことができるので、Ｘ線強度の低下も防ぐことができる。
【手続補正１２】
【補正対象書類名】明細書
【補正対象項目名】００２５
【補正方法】変更
【補正の内容】
【００２５】
なお、励起エネルギービームが通過する開口部またはＸ線が通過する別の開口部を排気用の開口部として兼用してもよい。また、飛散粒子遮蔽部材にガス導入用の開口部を設けることが好ましい。ガス導入用の開口部に真空容器外のガスボンベからの配管を接続して、標的部材と飛散粒子遮蔽部材との間の空間にガスを導入すれば、ガスにより飛散粒子を前記空間外に排出して、前記真空度の悪化を防ぐことができるので、Ｘ線強度の低下も防ぐことができる。
【手続補正１３】
【補正対象書類名】明細書
【補正対象項目名】００２７
【補正方法】変更
【補正の内容】
【００２７】
ガスの導入量は、標的部材と飛散粒子遮蔽部材との間の空間における、導入ガスによるＸ線吸収量が問題とならない程度にすることが好ましい。飛散粒子の放出量の方向分布を制御する飛散粒子側御部材であり、Ｘ線を取り出す方向への飛散粒子の放出量を低減させる飛散粒子制御部材をさらに設けると、Ｘ線の取り出し方向における飛散粒子阻止効果が増大するので好ましい。
【手続補正１４】
【補正対象書類名】明細書
【補正対象項目名】００２９
【補正方法】変更

【補正の内容】
【００２９】
本発明にかかる飛散粒子阻止部材を冷却する冷却手段をさらに設けると、該部材が飛散粒子を吸着しやすくなって、阻止効果が増大するので好ましい。或いは、飛散粒子を吸着しやすいように、飛散粒子阻止部材の表面を加工（例えば、つや消し加工）することも好ましい。本発明にかかる標的部材の形状は、巻き取り可能なテープ状が特に好ましいが板状、バルク状、円柱状でもよい。また、標的部材の材料は、Ｔａ，Ｗなどが好ましい。